# Optimal Currency Areas

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# *Optimal Currency Areas*

## *1. Introduction*

Is a country by definition an optimal currency area? If the optimal number of currencies is less than the number of existing countries, which countries should form currency areas?

This question, analyzed in the pioneering work of Mundell (1961) and extended in Alesina and Barro (2002), has jumped to the center stage of the current policy debate, for several reasons. First, the large increase in the number of independent countries in the world led, until recently, to a roughly one-for-one increase in the number of currencies. This proliferation of currencies occurred despite the growing integration of the world economy. On its own, the growth of international trade in goods and assets should have raised the transactions benefits from common currencies and led, thereby, to a decline in the number of independent moneys. Second, the memory of the inflationary decades of the seventies and eighties encouraged inflation control, thereby generating consideration of irrevocably fixed exchange rates as a possible instrument to achieve price stability. Adopting another country's currency or maintaining a currency board were seen as more credible commitment devices than a simple fixing of the exchange rate. Third, recent episodes of financial turbulence have promoted discussions about "new financial architectures." Although this dialogue is often vague and inconclusive, one of its interesting facets

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is the question of whether the one-country–one-currency dogma is still adequate.[1]

Looking around the world, one sees many examples of movement toward multinational currencies: twelve countries in Europe have adopted a single currency; dollarization is being implemented in Ecuador and El Salvador; and dollarization is under active consideration in many other Latin American countries, including Mexico, Guatemala, and Peru. Six West African states have agreed to create a new common currency for the region by 2003, and eleven members of the Southern African Development Community are debating whether to adopt the dollar or to create an independent monetary union possibly anchored to the South African rand. Six oil-producing countries (Saudi Arabia, United Arab Emirates, Bahrain, Oman, Qatar, and Kuwait) have declared their intention to form a currency union by 2010. In addition, several countries have maintained currency boards with either the U.S. dollar or the euro as the anchor. Currency boards are, in a sense, midway between a system of fixed rates and currency union, and the recent adverse experience of Argentina will likely discourage the use of this approach.

Currency unions typically take one of two forms. In one, which is most common, client countries (which are usually small) adopt the currency of a large anchor country. In the other, a group of countries creates a new currency and a new joint central bank. The second arrangement applies to the euro zone.[2] The Eastern Caribbean Currency Area (ECCA) and the CFA zone in Africa are intermediate between the two types of unions. In both cases, the countries have a joint currency and a joint central bank.[3] However, the ECCA currency (Caribbean dollar) has been linked since 1976 to the U.S. dollar (and, before that, to the British pound), and the CFA franc has been tied (except for one devaluation) to the French franc.

1. In principle, an optimal currency area could also be smaller than a country, that is, more than one currency could circulate within a country. However, we have not observed a tendency in this direction.
2. Some may argue that the European Monetary Union is, in practice, a German mark area, but this interpretation is questionable. Although the European central bank may be particularly sensitive to German preferences, the composition of the board and the observed policies in its first few years of existence do not show a German bias. See Alesina et al. (2001).
3. There are actually two regional central banks in the CFA zone. One is the BCEAO, grouping Benin, Burkina Faso, Ivory Coast, Guinea-Bissau, Mali, Niger, Senegal, and Togo, where the common currency is the *franc de la Communaute Financière de l'Afrique* or CFA franc. The other is the BEAC, grouping Cameroon, Central African Republic, Chad, Republic of Congo, Equatorial Guinea, and Gabon, with the common currency called the *franc de la Cooperation Financière Africaine*, also known as the CFA franc. The two CFA francs are legal tender only in their respective regions, but the two currencies have maintained a fixed parity. Comoros issues its own form of CFA franc but has maintained a fixed parity with the other two.

The purpose of this paper is to evaluate whether natural currency areas emerge from an empirical investigation. As a theoretical background, we use the framework developed by Alesina and Barro (2002), which discusses the trade-off between the costs and benefits of currency unions. Based on historical patterns of international trade and of comovements of prices and outputs, we find that there seem to exist reasonably well-defined dollar and euro areas but no clear yen area. However, a country's decision to join a monetary area should consider not just the situation that applies ex ante, that is, under monetary autonomy, but also the conditions that would apply ex post, that is, allowing for the economic effects of currency union. The effects on international trade have been discussed in a lively recent literature prompted by the findings of Rose (2000). We review this literature and provide new results. We also find that currency unions tend to increase the comovement of prices but are not systematically related to the comovement of outputs.

We should emphasize that we do not address other issues that are important for currency adoption, such as those related to financial markets, financial flows, and borrower–lender relationships.[4] We proceed this way not because we think that these questions are unimportant, but rather because the focus of the present inquiry is on different issues.

The paper is organized as follows. Section 2 discusses the broad evolution of country sizes, numbers of currencies, and currency areas in the post–World War II period. Section 3 reviews the implications of the theoretical model of Alesina and Barro (2002), which we use as a guide for our empirical investigation. Section 4 presents our data set. Section 5 uses the historical patterns in international trade flows, inflation rates, and the comovements of prices and outputs to attempt to identify optimal currency areas. Section 6 considers how the formation of a currency union would change bilateral trade flows and the comovements of prices and outputs. The last section concludes.

## 2. *Countries and Currencies*

In 1947 there were 76 independent countries in the world, whereas today there are 193. Many of today's countries are small: in 1995, 87 countries had a population less than 5 million. Figure 1, which is taken from Alesina, Spolaore, and Wacziarg (2000), depicts the numbers of countries created and eliminated in the last 150 years.[5] In the period between World Wars I and II, international trade collapsed, and international borders

4. For a recent theoretical discussion of these issues, see Gale and Vives (2002).
5. The initial negative bar in 1870 represents the unification of Germany.

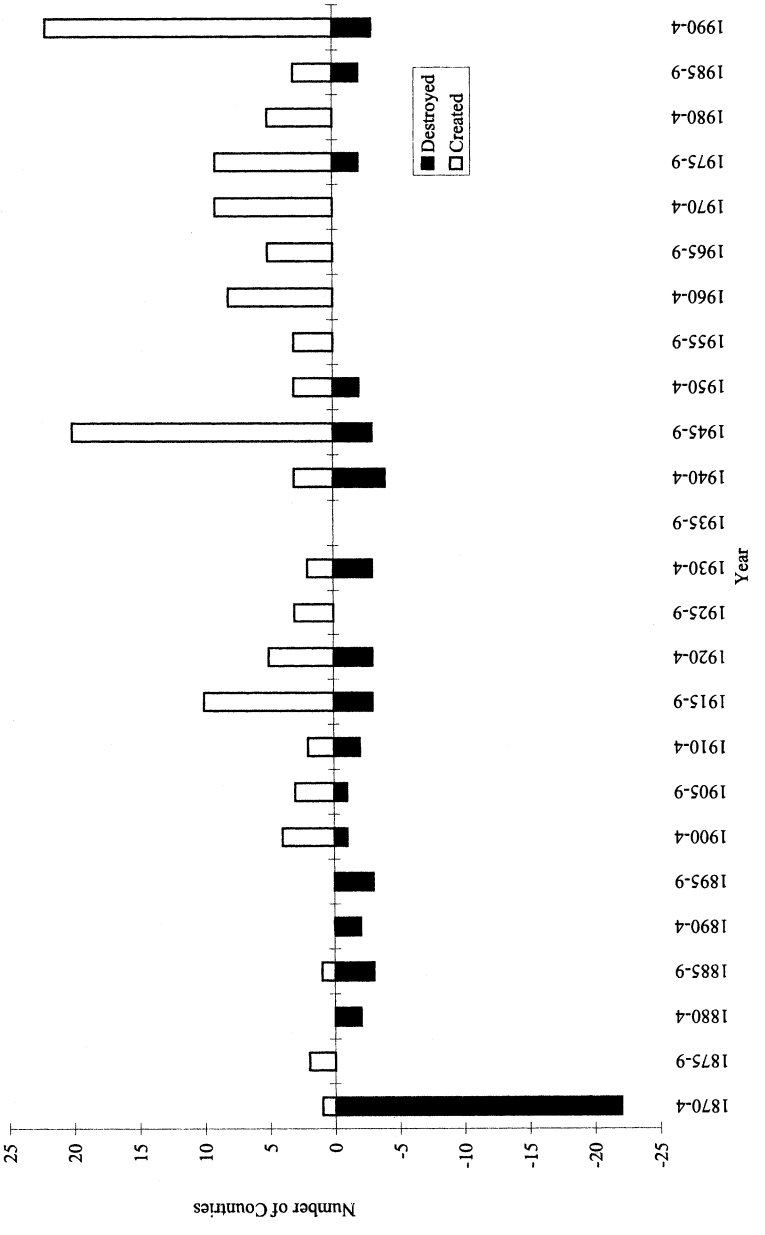



Figure 1 COUNTRIES CREATED AND DESTROYED (5-YEAR PERIODS; EXCLUDES SUB-SAHARAN AFRICA)

were virtually frozen. In contrast, after the end of World War II, the number of countries almost tripled, and the volume of international trade and financial transactions expanded dramatically. We view these two developments as interrelated. First, small countries are economically viable when their market is the world, in a free-trade environment. Second, small countries have an interest in maintaining open borders. Therefore, one should expect an inverse correlation between average country size and the degree of trade openness and financial integration.

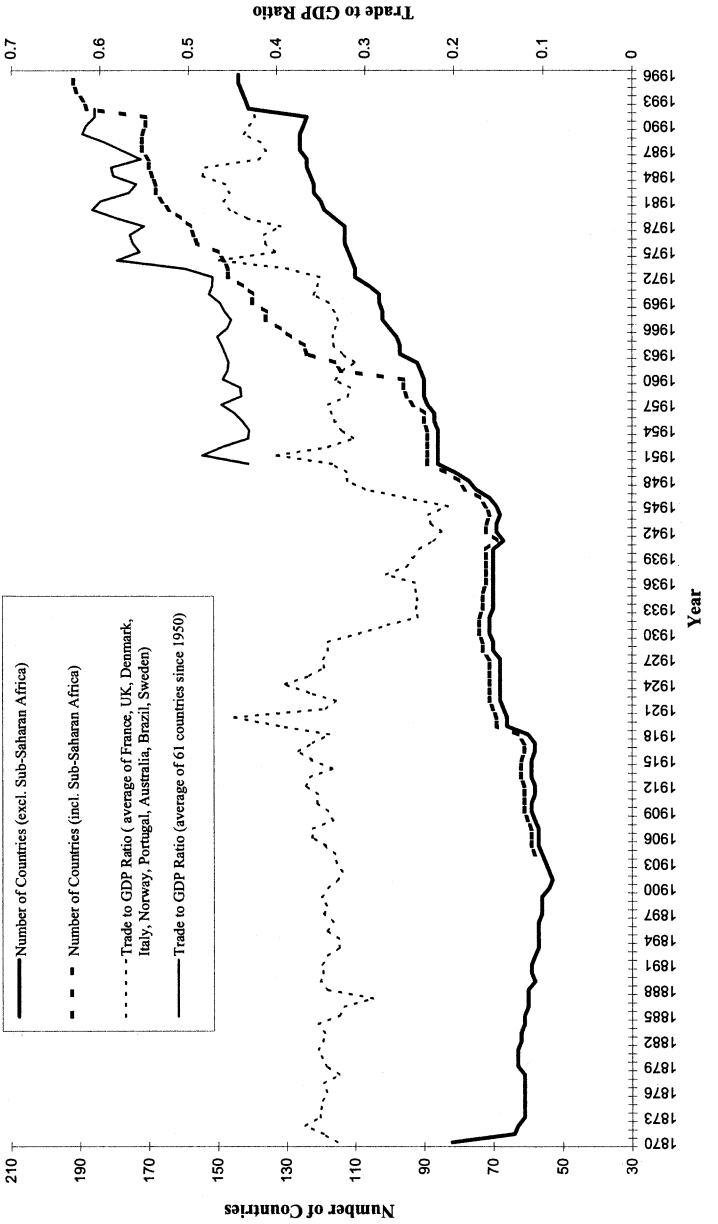
Figure 2, also taken from Alesina, Spolaore, and Wacziarg (2000), shows a strong positive correlation over the last 150 years between the detrended number of countries in the world and a detrended measure of the volume of international trade. These authors show that this correlation does not just reflect the relabeling of interregional trade as international trade when countries split. In fact, a similar pattern of correlation holds if one measures world trade integration by the volume of international trade among countries that did not change their borders. Alesina and Spolaore (2002) discuss these issues in detail and present current and historical evidence on the relationship between country formation and international trade.

The number of independent currencies has increased substantially, until recently almost at the same pace as the number of independent countries. In 1947, there were 65 currencies in circulation, whereas in 2001 there were 169. Between 1947 and 2001, the ratio of the number of currencies to the number of countries remained roughly constant at about 85%. Twelve of these currencies, in Europe, have now been replaced by the euro, so we now have 158 currencies.

The increase in the number of countries and the deepening of economic integration should generate a tendency to create multicountry currency areas, unless one believes that a country always defines the optimal currency area. One implication of Mundell's analysis is that political borders and currency boundaries should not always coincide. In fact, as discussed in Alesina and Spolaore (2002), small countries can prosper in a world of free trade and open financial markets. Nevertheless, these small countries may lack the size needed to provide effectively some public goods that are subject to large economies of scale or to substantial externalities. A currency may be one of these goods: a small country may be too small for an independent money to be efficient. To put it differently, an ethnic, linguistic, or culturally different group can enjoy political independence by creating its own country. At the same time, this separate country can avoid part of the costs of being economically small by using other countries to provide some public goods, such as a currency.

A country constitutes, by definition, an optimal currency area only if one views a national money as a critical symbol of national pride and identity.

Figure 2 TRADE OPENNESS AND THE NUMBER OF COUNTRIES



However, sometimes forms of nationalistic pride have led countries into disastrous courses of action. Therefore, the argument that a national currency satisfies nationalistic pride does not make an independent money economically or politically desirable. In fact, why a nation would take pride in a currency escapes us; it is probably much more relevant to be proud of an Olympic team. As for national identity, language and culture seem much more important than a currency, yet many countries have willingly retained the language of their former colonizers. Moreover, many countries undergoing extreme inflation, such as in South America, tended to change the names of their moneys frequently, so even a sentimental attachment to the name "peso" or "dollar" seems not to be so important.

In any event, as already mentioned, one can detect a recent tendency toward formation of multicountry monetary areas. In the next decade, the ratio of currencies to independent countries may decrease substantially, beginning with the adoption of the euro in 2002.

## 3. *The Costs and Benefits of Currency Unions*

We view this analysis from the perspective of a potential client country that is considering the adoption of another country's money as a nominal anchor.

### 3.1 TRADE BENEFITS

Country borders matter for trade flows: two regions of the same country trade much more with each other than they would if an international border were to separate them. McCallum (1995) looked at U.S.–Canadian trade in 1988 and suggested that this effect was extremely large: trade between Canadian provinces was estimated to be a staggering 2200% larger than that between otherwise comparable provinces and states. More recent work by Anderson and van Wincoop (2001) argues that this effect from the U.S.–Canada border was vastly exaggerated but is still substantial: the presence of an international border is estimated to reduce trade among industrialized countries by 30%, and between the United States and Canada by 44%. The question is why national borders matter so much for trade even when there are no explicit trade restrictions in place. Among other things, country borders tend to be associated with different currencies. Therefore, given that border effects are so large, the elimination of one source of border costs—the change of currencies—might have a large effect on trade.[6]

Alesina and Barro (2002) investigate the relationship between currency

6. Obstfeld and Rogoff (2000) argue that these border effects on trade may have profound effects on a host of financial markets and may explain a lot of anomalies in international financial transactions.

unions and trade flows. They model the adoption of a common currency as a reduction of iceberg trading costs between two countries. They find that, under reasonable assumptions about elasticities of substitution between goods, countries that trade more with each other benefit more from adopting the same currency.[7]

Thus, countries that trade more with each other stand to gain more from adopting the same currency. Also, smaller countries should, *ceteris paribus*, be more inclined to give up their currencies. Hence, as the number of countries increases (and their average size shrinks), the number of currencies in the world should increase less than proportionately.[8]

### 3.2 THE BENEFITS OF COMMITMENT

If an inflation-prone country adopts the currency of a credible anchor, it eliminates the inflation-bias problem pointed out by Barro and Gordon (1983). This bias may stem from two non-mutually-exclusive sources: an attempt to overstimulate the economy in a cyclical context, and the incentive to monetize budget deficits and debts.

A fixed-exchange-rate system, if totally credible, could achieve the same commitment benefit as a currency union. However, the recent world history shows that fixed rates are not irrevocably fixed; thus, they lack full credibility. Consequently, fixed exchange rates can create instability in financial markets. To the extent that a currency union is more costly to break than a promise to maintain a fixed exchange rate, the currency adoption is more credible. In fact, once a country has adopted a new currency, the costs of turning back are quite high, certainly much higher than simply changing a fixed parity to a new one. The ongoing situation in Argentina demonstrates that the government really had created high costs for breaking a commitment associated with a currency board and widespread dollarization of the economy. However, the costs were apparently not high enough to deter eventual reneging on the commitment.

A country that abandons its currency receives the inflation rate of the

7. The intuition for why this result does not hold unambiguously is the following. If two countries do not trade much with each other initially, the likely reason is that the trading costs are high. Hence, the trade that does occur must have a high marginal value. Specifically, if the trade occurs in intermediate inputs, then the marginal product of these inputs must be high, because the trade occurs only if the marginal product is at least as high as the marginal cost. In this case, the reduction of border costs due to the implementation of a currency union would expand trade in the intermediate goods that have an especially high marginal product. Hence, it is possible that the marginal gain from the introduction of a currency union would be greater when the existing volume of international trade is low.

8. Alesina and Barro (2002) show that, under certain conditions, an even stronger result holds: as the number of countries increases, the equilibrium number of currencies decreases.

anchor plus the change (positive or negative) in its price level relative to that of the anchor. In other words, if the inflation rate in the United States is 2%, then in Panama it will be 2% plus the change in relative prices between Panama and the United States. Therefore, even if the anchor maintains domestic price stability, linkage to the anchor does not guarantee full price stability for a client country.

The most likely anchors are large relative to the clients. In theory, a small but very committed country could be a perfectly good anchor. However, ex post, a small anchor may be subject to political pressure from the large client to abandon the committed policy. From an ex ante perspective, this consideration disqualifies the small country as a credible anchor.

In summary: The countries that stand to gain the most from giving up their currencies are those that have a history of high and volatile inflation. This kind of history is a symptom of a lack of internal discipline for monetary policy. Hence, to the extent that this lack of discipline tends to persist, such countries would benefit the most from the introduction of external discipline. Linkage to another currency is also more attractive if, under the linked system, relative price levels between the countries would be relatively stable.

### 3.3 STABILIZATION POLICIES

The abandonment of a separate currency implies the loss of an independent monetary policy. To the extent that monetary policy would have contributed to business-cycle stabilization, the loss of monetary independence implies costs in the form of wider cyclical fluctuations of output.

The costs of giving up monetary independence are lower the higher the association of shocks between the client and the anchor. The more the shocks are related, the more the policy selected by the anchor will be appropriate for the client as well. What turns out to matter is not the correlation of shocks per se, but rather the variance of the client country's output expressed as a ratio to the anchor country's output. This variance depends partly on the correlation of output (and, hence, of underlying shocks) and partly on the individual variances of outputs. For example, a small country's output may be highly correlated with that in the United States. But, if the small country's variance of output is much greater than that of the United States, then the U.S. monetary policy will still be inappropriate for the client. In particular, the magnitude of countercyclical monetary policy chosen by the United States will be too small from the client's perspective.

The costs implied by the loss of an independent money depend also on the explicit or implicit contract that can be arranged between the anchor and its clients. We can think of two cases. In one, the anchor does

not change its monetary policy regardless of the composition and experience of its clients. Thus, clients that have more shocks in common with the anchor stand to lose less from abandoning their independent policy but have no influence on the monetary policy chosen by the anchor country. In the other case, the clients can compensate the anchor to motivate the selection of a policy that takes into account the clients' interests, which will reflect the shocks that they experience. The ability to enter into such contracts makes currency unions more attractive. However, even when these agreements are feasible, the greater the association of shocks between clients and anchor, the easier it is to form a currency union. Specifically, it is cheaper for a client to buy accommodation from an anchor that faces shocks that are similar to those faced by the clients.[9] The allocation of seignorage arising from the client's use of the anchor's currency can be made part of the compensation schemes.

The European Monetary Union is similar to this arrangement with compensation, because the monetary policy of the union is not targeted to a specific country (say Germany), but rather to a weighted average of each country's shocks, that is, to aggregate euro-area shocks. In the discussion leading up to the formation of the European Monetary Union, concerns about the degree of association among business cycles across potential members were critical. In practice, the institutional arrangements within the European Union are much more complex than a compensation scheme, but the point is that the ECB does not target the shocks of any particular country, but rather the average European shocks.[10]

In the case of developing countries, the costs of abandoning an independent monetary policy may not be that high, because stabilization policies are typically not well used when exchange rates are flexible. Recent work by Calvo and Reinhart (2002) and Hausmann, Panizza, and Stein (1999) suggests that developing countries tend to follow procyclical monetary policies; specifically, they tend to raise interest rates in times of distress to defend the value of their currency.[11] To the extent that monetary policy is not properly used as a stabilization device, the loss of monetary independence is not a substantial cost (and may actually be a benefit) for

9. Note that, in theory, a small country could be an ideal anchor because it is cheaper to compensate such an anchor for the provision of monetary services that are tailored to the interests of clients. However, as discussed before, a small anchor may lack credibility.

10. The European Union also has specific prescriptions about the allocation of seignorage. The amounts are divided according to the share of GDP of the various member countries. For a discussion of the European Central Bank policy objectives and how this policy relates to individual country shocks, see Alesina et al. (2001).

11. A literature on Latin America, prompted mostly by a paper by Gavin and Perotti (1997), has also shown that fiscal policy has the wrong cyclical properties. That is, surpluses tend to appear during recessions, and deficits during expansions.

developing countries. However, recent work by Broda (2001) shows that countries with floating-exchange-rate systems show superior performance in the face of terms-of-trade shocks. This pattern may reflect the benefits from independent monetary policies.

To summarize, the countries that have the largest comovements of outputs and prices with potential anchors are those with the lowest costs of abandoning monetary independence.

### 3.4 TRADE, GEOGRAPHY, AND COMOVEMENTS

Countries that trade more can benefit more from currency unions for the reasons already discussed. Increased trade may also raise the comovements of outputs and prices. In this case, there is a second reason why countries that trade more would have a greater net benefit from adopting a currency union.

An established literature on the gravity model of trade shows that bilateral trade volumes are well explained by a set of geographical and economic variables, such as the distance between the countries and the sizes and incomes of the countries. Note that the term "distance" has to be interpreted broadly to include not only literal geographical distance, but also whether the countries share a common language, legal system, and so on. In addition, some geographical variables may influence comovements of outputs and prices beyond their effects through trade. For example, locational proximity and weather patterns may relate to the nature of underlying shocks, which in turn influence the comovements.

Whether more trade always means more comovements of outputs and prices is not a settled issue. On the theoretical side, the answer depends largely on whether trade is interindustry or intraindustry. In the latter case, more trade likely leads to more comovements. However, in the former case, increased trade may stimulate sectoral specialization across countries. This heightened specialization likely lowers the comovements of outputs and prices, because industry-specific shocks become country-specific shocks.[12] The type of trade between two countries is also likely influenced by the levels of per capita GDP; for example, intraindustry trade tends to be much more important for rich countries.

In summary, geographical or gravity variables affect bilateral trade and, as a result, the costs and benefits of currency unions. Some geographical variables may have an effect on the attractiveness of currency unions beyond those operating through the trade channel.

12. See Frankel and Rose (1998) for the argument that more trade favors more correlated business cycles. See Krugman (1993) for the opposite argument. For an extensive theoretical and empirical discussion of these issues, see Ozcan, Sorensen, and Yosha (2001, 2002) and Imbs (2000).

## 4. *Data and Methodology*

### 4.1 DATA DESCRIPTION AND SOURCES

Data on outputs and prices come from the World Bank's World Development Indicators (WDI) and Penn World Tables 5.6. Combining both sources, we form a panel of countries with yearly data on outputs and prices from 1960 to 1997 (or, in some cases, for shorter periods). For output, we use real per capita GDP expressed in 1995 U.S. dollars. To compute relative prices, we use a form of real exchange rate relating to the price level for gross domestic products. The measure is the purchasing-power parity (PPP) for GDP divided by the U.S. dollar exchange rate.[13] In the first instance, this measure gives us the price level in country $i$ relative to that in the United States, $P_{i,t}/P_{US,t}$. We then compute relative prices between countries $i$ and $j$ by dividing the value for country $i$ by that for country $j$. Inflation is computed as the continuously compounded (log-difference) growth rate of the GDP deflator, coming from WDI.

Bilateral trade information comes from Glick and Rose (2002), who in turn extracted it from the International Monetary Fund's *Direction of Trade Statistics*. These data are expressed in real U.S. dollars.[14]

To compute bilateral distances, we use the great-circle-distance algorithm provided by Gray (2002). Data on location, as well as contiguity, access to water, language, and colonial relationships come from the *CIA World Fact Book 2001*. Data on free-trade agreements come from Glick and Rose (2002) and are complemented with data from the World Trade Organization Web page.

### 4.2 THE COMPUTATION OF COMOVEMENTS

We pair all countries and calculate bilateral relative prices, $P_{it}/P_{jt}$. (This ratio measures the value of one unit of country $i$'s output relative to one unit of country $j$'s output.) This procedure generates 21,321 ($207 \times 206/2$) country pairs for each year. For every pair of countries, $(i, j)$, we use the annual time series $\{\ln(P_{it}/P_{jt})\}_{t=1960}^{t=1997}$ to compute the second-order autoregression[15]:

13. $P_i$ = (PPP of GDP)/(ex. rate) measures how many units of U.S. output can be purchased with one unit of country $i$'s output, that is, it measures the relative price of country $i$'s output with respect to that of the United States. By definition, this price is always 1 when $i$ is the United States.
14. Glick and Rose (2002) deflated the original nominal values of trade by the U.S. consumer price index, with 1982–1984 = 100. We use the same index to express trade values in 1995 U.S. dollars.
15. We use fewer observations when the full time series from 1960 to 1997 is unavailable. However, we drop country pairs for which fewer than 20 observations are available.

$$\ln \frac{P_{it}}{P_{jt}} = b_0 + b_1 \ln \frac{P_{i,t-1}}{P_{j,t-1}} + b_2 \ln \frac{P_{i,t-2}}{P_{j,t-2}} + \varepsilon_{tij}.$$

The estimated residual, $\hat{\varepsilon}_{t,i,j}$, measures the relative price that would not be predictable from the two prior values of relative prices. We then use as a measure of (lack of) comovement of relative prices the root-mean-square error:

$$VP_{ij} \equiv \sqrt{\frac{1}{T-3} \sum_{t=1}^{T} \hat{\varepsilon}_{tij}^2}.$$

The lower $VP_{ij}$, the greater the comovement of prices between countries $i$ and $j$.

We proceed analogously to compute a measure of output comovement. The value of $VY_{ij}$ comes from the estimated residuals from the second-order autoregression on annual data for relative per capita GDP:

$$\ln \frac{Y_{it}}{Y_{jt}} = c_0 + c_1 \ln \frac{Y_{i,t-1}}{Y_{j,t-1}} + c_2 \ln \frac{Y_{i,t-2}}{Y_{j,t-2}} + u_{tij}.$$

The estimated residual $\hat{u}_{tij}$ measures the relative output that would not be predictable from the two prior values of relative output. We then use as a measure of (lack of) comovement of relative outputs the root-mean-square error:

$$VY_{ij} \equiv \sqrt{\frac{1}{T-3} \sum_{t=1}^{T} \hat{u}_{tij}}.$$

The lower $VY_{ij}$, the greater the comovement of outputs between countries $i$ and $j$.

For most countries all of the data are available. We exclude from the computation of comovements country pairs for which we do not have at least 20 observations. Note that this limitation implies that we cannot include in our analysis most of central and eastern Europe, a region in which some countries are likely clients of the euro.

## 5. *Which Currency Areas?*

In this section, we sketch "natural" currency areas, based on the criteria discussed above. For anchor currencies, we consider the U.S. dollar, the euro, and the yen. We are not assuming that all countries have to belong to one of the unions centered around these three currencies. In fact, many countries turn out not to be good clients for any of the anchors and seem to be better off keeping their own currency. Therefore, we are addressing the question of which countries would be better served by joining some currency union, as well as the question of which anchor should be chosen if one is needed.

### 5.1 INFLATION, TRADE, AND COMOVEMENTS

We begin in Table 1 by showing the average inflation rate, using the GDP deflator, for selected countries and groups in our sample from 1970 to 1990. We stopped at 1990 because in the 1990s several countries adopted currency arrangements, such as the EMS, that contributed to reduced inflation. We are interested here mostly in capturing inflation rates that would arise in the absence of a monetary anchor. We take the 1970s and 1980s (that is, after Bretton Woods and before the recent emphasis on nominal anchors) as a period with few true monetary anchors. We show the 20 countries with the highest average inflation rates, along with the averages for industrialized countries and for regional groups of developing countries.

The top average rates of inflation are all Latin American countries, and 7 Latin American countries are in the top 11. The top 5 countries had an average annual inflation rate above 280%. Despite its poor economic performance in other dimensions, Africa does not have a very high average inflation rate. While there are 6 African countries in the top 20, the average for the continent is brought down by the countries in the CFA franc zone, which have relatively low inflation records. The Middle East is the second highest inflation group, with two countries, Israel and Lebanon, in the top 13 with inflation rates of 78% and 44%, respectively. In the euro zone, Greece and Italy lead in the rankings, with inflation rates of 16% and 13%, respectively. Overall, 11 countries had an average annual inflation rate above 50%, 30 countries above 20%, and 72 countries above 10%.

Table 2 shows inflation variability and is organized in the same way as Table 1. Since average inflation and inflation variability are strongly positively correlated, 16 of the top 20 countries in Table 1 are also in the top 20 of Table 2. However, in some cases, such as Chile, the high average inflation rate (107%) reflected one episode of hyperinflation followed by relative stability. In others, such as Colombia, the fairly high average in-

Table 1 MEAN ANNUAL INFLATION RATE 1970–1990[a]

| *Region* | *Rate (%/yr)* |
|---|---|
| ***High-Inflation Countries***[b] | |
| Nicaragua | 1168 |
| Bolivia | 702 |
| Peru | 531 |
| Argentina | 431 |
| Brazil | 288 |
| Vietnam | 213 |
| Uganda | 107 |
| Chile | 107 |
| Cambodia | 80 |
| Israel | 78 |
| Uruguay | 62 |
| Congo, Dem. Rep. | 49 |
| Lebanon | 44 |
| Lao PDR | 42 |
| Mexico | 41 |
| Mozambique | 41 |
| Somalia | 40 |
| Turkey | 39 |
| Ghana | 39 |
| Sierra Leone | 34 |
| ***Industrial Countries***[c] | |
| All | 9.8 |
| ***Developing Countries***[c] | |
| Africa | 16.3 |
| Asia | 17.4 |
| Europe | 6.9 |
| Middle East | 19.6 |
| Western Hemisphere | 98.6 |

[a] Based on GDP deflators. Source: WDI 2001.
[b] This group includes only countries with 1997 population above 500,000. Ranked by inflation rate.
[c] Unweighted means.

flation rate (22%) resulted from a long period of moderate, double-digit inflation.

Tables 3, 4, and 5 list for selected countries and groups the average trade-to-GDP ratios[16] over 1960–1997 with three potential anchors for currency areas: the United States, the euro area (based on the twelve mem-

16. The trade measure is equivalent to the average of imports and exports. Glick and Rose's (2002) values come from averaging four measures of bilateral trade (as reported for imports and exports by the partners on each side of both transactions).

Table 2 INFLATION-RATE VARIABILITY 1970–1990[a]

| *Region* | *Variability (%/yr)* |
|---|---|
| ***Countries with High Inflation Variability***[b] | |
| Nicaragua | 3197 |
| Bolivia | 2684 |
| Peru | 1575 |
| Argentina | 749 |
| Brazil | 589 |
| Chile | 170 |
| Vietnam | 160 |
| Israel | 95 |
| Cambodia | 63 |
| Uganda | 63 |
| Mozambique | 52 |
| Somalia | 50 |
| Oman | 46 |
| Lebanon | 41 |
| Kuwait | 38 |
| Uruguay | 38 |
| Guinea-Bissau | 37 |
| Mexico | 37 |
| Guyana | 36 |
| Congo, Dem. Rep | 36 |
| ***Industrial Countries***[c] | |
| All | 4.6 |
| ***Developing Countries***[c] | |
| Africa | 13.9 |
| Asia | 14.0 |
| Europe | 6.6 |
| Middle East | 28.4 |
| Western Hemisphere | 251.2 |

[a] Standard deviation of annual inflation rates, based on GDP deflators. Source: WDI 2001.
[b] This group includes only countries with 1997 population above 500,000. Ranked by standard deviation of inflation.
[c] Unweighted means.

Table 3 AVERAGE TRADE-TO-GDP RATIO WITH THE UNITED STATES, 1960–1997[a]

| *Region* | *Ratio (%)* |
|---|---|
| ***High-Trade-Ratio Countries***[b] | |
| Trinidad and Tobago | 29.6 |
| Honduras | 24.3 |
| Guyana | 23.0 |
| Jamaica | 19.4 |
| Angola | 19.0 |
| Canada | 18.3 |
| Dominican Republic | 16.8 |
| Nigeria | 15.0 |
| Singapore | 13.2 |
| Panama | 12.2 |
| Nicaragua | 12.1 |
| Venezuela | 11.7 |
| Costa Rica | 11.3 |
| Hong Kong | 11.0 |
| Ecuador | 9.9 |
| Haiti | 9.6 |
| Mexico | 8.7 |
| Gabon | 8.0 |
| Congo, Rep. | 7.9 |
| Guatemala | 7.5 |
| ***Industrial Countries***[c] | |
| All | 2.5 |
| ***Developing Countries***[c] | |
| Africa | 3.3 |
| Asia | 3.7 |
| Europe | 0.8 |
| Middle East | 4.2 |
| Western Hemisphere | 12.9 |

[a] Trade is the average of imports and exports. (Imports is the average of the values reported by the importer and the exporter. Idem for exports.) Averages are for 1960–1997 (when GDP data are not available, the average corresponds to the period of availability). The equations for comovement include only one observation for each pair, corresponding to the period 1960–1997. The explanatory variables then refer to averages over time. Source: Glick and Rose (trade values; WDI 2001 (GDP).

[b] This group includes only countries with 1997 population above 500,000.

[c] Unweighted means.

Table 4 AVERAGE TRADE-TO-GDP RATIO WITH THE EURO 12, 1960–1997[a]

| *Region* | *Ratio (%)* |
|---|---|
| ***High Trade-Ratio Countries***[b] | |
| Mauritania | 34.8 |
| Congo, Rep. | 28.3 |
| Guinea-Bissau | 27.5 |
| Côte d'Ivoire | 24.5 |
| Algeria | 24.4 |
| Belgium-Lux. | 23.4 |
| Gabon | 23.0 |
| Togo | 22.9 |
| Nigeria | 22.8 |
| Tunisia | 20.9 |
| Gambia, The | 20.6 |
| Senegal | 20.4 |
| Comoros | 19.3 |
| Netherlands | 18.2 |
| Oman | 17.7 |
| Cameroon | 17.3 |
| Congo, Dem. Rep. | 17.0 |
| Slovenia | 16.9 |
| Angola | 15.6 |
| Syrian Arab Republic | 15.2 |
| ***Industrial Countries***[c] | |
| Ali | 7.3 |
| ***Developing Countries***[c] | |
| Africa | 14.2 |
| Asia | 4.3 |
| Europe | 7.0 |
| Middle East | 11.6 |
| Western Hemisphere | 8.3 |

[a] Trade is the average of imports and exports. (Imports is the average of the values reported by the importer and the exporter. Idem for exports.) Averages are for 1960–1977 (when GDP data are not available, the average corresponds to the period of availability). Source: Glick & Rose (trade values); WDI 2001 (GDP). For a Euro 12 country, the trade ratios apply to the other 11 countries.

[b] This group includes only countries with 1997 population above 500,000.

[c] Underweight means.

Table 5 AVERAGE TRADE-TO-GDP RATIO WITH JAPAN, 1960–1997[a]

| *Region* | *Ratio (%)* |
|---|---|
| ***High-Trade-Ratio Countries***[b] | |
| Oman | 16.0 |
| United Arab Emirates | 15.7 |
| Panama | 14.1 |
| Singapore | 12.8 |
| Kuwait | 9.5 |
| Malaysia | 9.5 |
| Papua New Guinea | 9.2 |
| Bahrain | 8.4 |
| Saudi Arabia | 8.0 |
| Hong Kong, China | 7.9 |
| Indonesia | 7.8 |
| Swaziland | 6.5 |
| Thailand | 5.6 |
| Gambia, The | 5.5 |
| Mauritania | 5.4 |
| Iran, Islamic Rep. | 5.4 |
| Philippines | 4.8 |
| Korea, Rep. | 4.1 |
| Nicaragua | 3.9 |
| Fiji | 3.7 |
| ***Industrial Countries***[c] | |
| All | 0.8 |
| ***Developing Countries***[c] | |
| Africa | 1.4 |
| Asia | 5.5 |
| Europe | 0.3 |
| Middle East | 6.1 |
| Western Hemisphere | 2.0 |

[a] Trade is the average of imports and exports. (Imports is the average of the values reported by the importer and the exporter. Idem for exports.) Averages are for 1960–1997 (when GDP data are not available, the average corresponds to the period of availability). Source: Glick and Rose (trade values); WDI 2001 (GDP).

[b] This group includes only countries with 1997 population above 500,000.

[c] Unweigted means.

bers), and Japan. The GDP value in the denominator of these ratios refers to the country paired with the potential anchor.

The tables show that Japan is an economy that is relatively closed; moreover, in comparison with the United States and the euro region, Japan's trade is more dispersed across partners. Hence, few countries exhibit a high trade-to-GDP ratio with Japan. Notably, industrial countries' average trade share with Japan is below 1%. Among developing countries, oil exporters have a high trade share with Japan, but still below that with the Euro 12. Singapore, Malaysia, Hong Kong, and Indonesia exhibit relatively high trade-to-GDP ratios with Japan (above 7%), but Singapore and Hong Kong trade even more with the United States. For the United States, aside from Hong Kong and Singapore, a good portion of Latin America has a high ratio of trade to GDP. Canada is notable for trading almost exclusively with the United States; its trade ratio is 18%, compared with 1.7% for the Euro 12 and 1.4% for Japan. African countries, broadly speaking, trade significantly more with Europe, but some of them, such as Angola and Nigeria, are also closely linked with the United States.

Tables 6, 7, and 8 report our measures of the comovements of prices for selected countries with the United States, the Euro 12 area, and Japan.[17] Remember that a larger number means less comovement. Panama and Puerto Rico, which use the U.S. dollar, have the highest comovements of prices with the United States. These two are followed by Canada and El Salvador, which has recently dollarized. Members of the OECD have fairly high price comovements with all three of the potential anchors (which are themselves members of the OECD). For Japan, the countries that are most closely related in terms of price comovements lack a clear geographical distribution. For the Euro 12, the euro members and other western European countries have a high degree of price comovement. African countries also have relatively high price comovements with the Euro 12, higher than that with the United States.

Tables 9, 10, and 11 report our measures of the comovements of outputs (per capita GDPs) for selected countries with the United States, the Euro 12 area, and Japan.[18] The general picture is reasonably similar to that for prices. Note that all of the OECD countries have relatively high output comovements with the three anchors, particularly with the Euro 12. Japan's business cycle seems to be somewhat less associated with the rest of the world: even developing countries in Asia tend to exhibit, on average, higher output comovements with the Euro 12. The regional patterns

17. Recall that we compute comovements only for pairs of countries for which we have at least 20 annual observations.

18. As for prices, we consider only pairs of countries for which we have at least 20 observations.

Table 6 COMOVEMENT OF PRICES WITH THE UNITED STATES, 1960–1997[a]

| *Region* | *VP* |
|---|---|
| ***High-Comovement Countries***[b] | |
| Puerto Rico | 0.0193 |
| Panama | 0.0244 |
| Canada | 0.0335 |
| El Salvador | 0.0340 |
| Singapore | 0.0444 |
| Thailand | 0.0529 |
| Guinea | 0.0545 |
| Bahrain | 0.0563 |
| Hong Kong, China | 0.0566 |
| Honduras | 0.0571 |
| Malaysia | 0.0609 |
| Saudi Arabia | 0.0646 |
| Australia | 0.0664 |
| Fiji | 0.0666 |
| Hungary | 0.0673 |
| Egypt, Arab Rep. | 0.0681 |
| Cyprus | 0.0687 |
| Tunisia | 0.0689 |
| New Zealand | 0.0691 |
| Norway | 0.0671 |
| ***Industrial Countries***[c] | |
| All | 0.0830 |
| ***Developing Countries***[c] | |
| Africa | 0.1445 |
| Asia | 0.0913 |
| Europe | 0.1107 |
| Middle East | 0.1348 |
| Western Hemisphere | 0.1040 |

[a] The table shows the value *VP*, the standard error of the residual for the AR(2) regression for the log of the real exchange rate. In some cases, the sample differs from 1960–1997.

[b] This group includes only countries with 1997 population above 500,000.

[c] Unweighted means.

Table 7 COMOVEMENT OF PRICES WITH THE EURO 12, 1960–1997[a]

| *Region* | *VP* |
|---|---|
| ***High-Comovement Countries***[b] | |
| Austria | 0.0196 |
| Netherlands | 0.0217 |
| Denmark | 0.0219 |
| Belgium | 0.0242 |
| Germany | 0.0328 |
| France | 0.0338 |
| Norway | 0.0363 |
| Switzerland | 0.0395 |
| Ireland | 0.0397 |
| Morocco | 0.0426 |
| Italy | 0.0478 |
| Portugal | 0.0480 |
| Sweden | 0.0489 |
| Spain | 0.0491 |
| Greece | 0.0510 |
| Tunisia | 0.0529 |
| Cyprus | 0.0536 |
| Finland | 0.0552 |
| United Kingdom | 0.0616 |
| New Zealand | 0.0678 |
| ***Industrial Countries***[c] | |
| All | 0.0507 |
| ***Developing Countries***[c] | |
| Africa | 0.1403 |
| Asia | 0.1103 |
| Europe | 0.1152 |
| Middle East | 0.1607 |
| Western Hemisphere | 0.1350 |

[a] The table shows the value of *VP*, the standard error of the residual for the ARC(2) regression for the log of the real exchange rate. For a member of the Euro 12, the comovement is in relation to the other 11 countries. In some cases, the sample differs from 1960–1997.

[b] This group includes only countries with 1997 population above 500,000.

[c] Unweighted means.

Table 8 COMOVEMENT OF PRICES WITH JAPAN, 1960–1997[a]

| *Region* | *VP* |
|---|---|
| ***High-Comovement Countries***[b] | |
| Switzerland | 0.0713 |
| Austria | 0.0719 |
| Germany | 0.0776 |
| New Zealand | 0.0791 |
| Netherlands | 0.0805 |
| Denmark | 0.0810 |
| Belgium | 0.0816 |
| Papua New Guinea | 0.0827 |
| Thailand | 0.0841 |
| Cyprus | 0.0845 |
| Singapore | 0.0866 |
| France | 0.0883 |
| Norway | 0.0883 |
| Morocco | 0.0918 |
| United States | 0.0924 |
| Australia | 0.0940 |
| Panama | 0.0944 |
| Malaysia | 0.0947 |
| Tunisia | 0.0960 |
| Puerto Rico | 0.0961 |
| ***Industrial Countries***[c] | |
| All | 0.0919 |
| ***Developing Countries***[c] | |
| Africa | 0.1647 |
| Asia | 0.1237 |
| Europe | 0.1307 |
| Middle East | 0.1730 |
| Western Hemisphere | 0.1465 |

[a] The table shows the value of *VP*, the standard error of the residual for the AR(2) regression for the log of the real exchange rate. In some cases, the sample differs from 1960–1997.
[b] This group includes only countries with 1997 population above 500,000.
[c] Unweighted means.

Table 9 COMOVEMENT OF OUTPUTS WITH THE UNITED STATES, 1960–1997[a]

| *Region* | *VY* |
|---|---|
| ***High-Comovement Countries***[b] | |
| Canada | 0.0135 |
| United Kingdom | 0.0150 |
| Australia | 0.0175 |
| Germany | 0.0196 |
| Netherlands | 0.0197 |
| France | 0.0200 |
| Colombia | 0.0205 |
| Puerto Rico | 0.0216 |
| Denmark | 0.0217 |
| Norway | 0.0224 |
| Italy | 0.0230 |
| Spain | 0.0238 |
| Honduras | 0.0251 |
| Belgium | 0.0253 |
| Sweden | 0.0254 |
| Switzerland | 0.0256 |
| Costa Rica | 0.0258 |
| Austria | 0.0261 |
| Japan | 0.0265 |
| Guatemala | 0.0265 |
| ***Industrial Countries***[c] | |
| All | 0.0251 |
| ***Developing Countries***[c] | |
| Africa | 0.0591 |
| Asia | 0.0524 |
| Europe | 0.0449 |
| Middle East | 0.0749 |
| Western Hemisphere | 0.0442 |

[a] The table shows the value of *VY*, the standard error of the residual for the AR(2) regression for the log of the ratio of real per capita GDPs. In some cases, the sample differs from 1960–1997.
[b] This group includes only countries with 1997 population above 500,000.
[c] Unweighted means.

Table 10 COMOVEMENT OF OUTPUTS WITH THE EURO 12, 1960–1997[a]

| *Region* | *VY* |
|---|---|
| ***High-Comovement Countries***[b] | |
| France | 0.0094 |
| Belgium | 0.0108 |
| Netherlands | 0.0116 |
| Austria | 0.0131 |
| Colombia | 0.0145 |
| Italy | 0.0154 |
| Germany | 0.0154 |
| Sweden | 0.0165 |
| Spain | 0.0165 |
| Switzerland | 0.0168 |
| United Kingdom | 0.0170 |
| Denmark | 0.0177 |
| United States | 0.0185 |
| Canada | 0.0187 |
| Japan | 0.0202 |
| Puerto Rico | 0.0205 |
| Norway | 0.0210 |
| Guatemala | 0.0220 |
| Australia | 0.0222 |
| Cyprus | 0.0227 |
| ***Industrial Countries***[c] | |
| All | 0.0198 |
| ***Developing Countries***[c] | |
| Africa | 0.0557 |
| Asia | 0.0500 |
| Europe | 0.0421 |
| Middle East | 0.0713 |
| Western Hemisphere | 0.0426 |

[a] The table shows the value of *VY*, the standard error of the residual for the AR(2) regression for the log of the ratio of real per capita GDPs. In some cases, the sample differs from 1960–1997. For a member of the Euro 12, the comovement is in relation to the other 11 countries.

[b] This group includes only countries with 1997 population above 500,000.

[c] Unweighted means.

Table 11 COMOVEMENT OF OUTPUTS WITH JAPAN, 1960–1997[a]

| *Region* | *VY* |
|---|---|
| ***High-Comovement Countries***[b] | |
| France | 0.0214 |
| United Kingdom | 0.0217 |
| Germany | 0.0229 |
| Austria | 0.0234 |
| Netherlands | 0.0235 |
| Italy | 0.0236 |
| Belgium | 0.0243 |
| Colombia | 0.0252 |
| Australia | 0.0254 |
| Sweden | 0.0256 |
| Greece | 0.0260 |
| Switzerland | 0.0262 |
| Puerto Rico | 0.0262 |
| Denmark | 0.0265 |
| United States | 0.0265 |
| Sri Lanka | 0.0271 |
| Spain | 0.0272 |
| Thailand | 0.0282 |
| Cyprus | 0.0286 |
| Canada | 0.0296 |
| ***Industrial Countries***[c] | |
| All | 0.0282 |
| ***Developing Countries***[c] | |
| Africa | 0.0596 |
| Asia | 0.0541 |
| Europe | 0.0443 |
| Middle East | 0.0748 |
| Western Hemisphere | 0.0463 |

[a] The table shows the value of *VY*, the standard error of the residual for the AR(2) regression for the log of the ratio of real per capita GDPs. In some cases, the sample differs from 1960–1997.
[b] This group includes only countries with 1997 population above 500,000.
[c] Unweighted means.

show that Africa is generally more associated with the Euro 12, whereas there is more ambiguity for Latin America.

Overall, Japan is a worse anchor than the United States and the Euro 12, in that fewer countries are associated with Japan in price and output comovements, and trade flows to Japan are more dispersed across partners. Africa is more associated in price and output comovements with the Euro 12 than with the United States, and Africa also trades more with the euro zone. North America is highly associated with the United States. As for Latin America, this region trades overall more with the United States than with the euro zone or Japan. However, comovements of prices and outputs for this region are not much higher with the United States than they are with the Euro 12. An interesting case is Argentina. In comovements of prices and outputs, Argentina is more associated with the euro area than with the United States. Mexico, in contrast, is much more associated in its price and output comovements with the United States. In Asia, Hong Kong and Singapore are more associated with the United States than with Japan.

Looking at the tables, the patterns of trade and price and output comovements suggest geographically connected areas that are linked to the U.S. dollar (North and part of South America) and the euro (Europe and Africa). For Japan, at most a small part of east Asia seems to apply.

### 5.2 WHICH CURRENCY UNIONS?

This subsection brings together the data already presented to discuss which currency unions appear most attractive in terms of the criteria suggested by the underlying theory. The natural clients, with respect to the three proposed anchors, are those countries that have no ability to commit to low inflation (as evidenced by a history of high and variable inflation), that trade a lot (at least potentially) with the anchor, and that have high price and output comovements with the anchor. The implicit assumption here is that the patterns for trade and comovements that apply ex ante (under monetary autonomy) would also apply at least in a relative sense ex post (under a currency union).

We begin in Table 12 by listing the 28 countries in our sample with average inflation rates of at least 15% per year from 1970 to 1990.[19] We suggest that these countries are likely to have a high demand for an external nominal anchor because of their evident lack of commitment to low inflation. We then list for these countries their trade shares and measures of price and output comovements with the three potential anchors.

19. We restrict this analysis to countries with populations larger than 500,000 in 1997. The analysis is also constrained by data availability: only countries with data on comovements of output and prices are considered.

Table 12 HIGH-INFLATION COUNTRIES[a]: TRADE RATIOS AND COMOVEMENTS WITH THE UNITED STATES, THE EURO 12, AND JAPAN

| *Country* | *Mean annual inflation rate (%)* | *Trade ratio with U.S.* | *Trade ratio with Euro 12* | *Trade ratio with Japan* | VP *with U.S.* | VP *with Euro 12* | VP *with Japan* | VY *with U.S.* | VY *with Euro 12* | VY *with Japan* |
|---|---|---|---|---|---|---|---|---|---|---|
| Nicaragua | 1168 | 0.121 | 0.079 | 0.039 | 0.521 | 0.530 | 0.551 | 0.078 | 0.077 | 0.082 |
| Bolivia | 702 | 0.053 | 0.032 | 0.014 | 0.105 | 0.155 | 0.150 | 0.043 | 0.043 | 0.049 |
| Peru | 531 | 0.035 | 0.024 | 0.011 | 0.135 | 0.134 | 0.157 | 0.057 | 0.055 | 0.060 |
| Argentina | 431 | 0.009 | 0.017 | 0.003 | 0.255 | 0.230 | 0.251 | 0.060 | 0.056 | 0.062 |
| Brazil | 288 | 0.015 | 0.015 | 0.004 | 0.122 | 0.133 | 0.155 | 0.042 | 0.035 | 0.041 |
| Chile | 107 | 0.047 | 0.051 | 0.021 | 0.116 | 0.139 | 0.140 | 0.050 | 0.052 | 0.058 |
| Israel | 78 | 0.052 | 0.069 | 0.007 | 0.092 | 0.099 | 0.124 | 0.038 | 0.032 | 0.039 |
| Uruguay | 62 | 0.014 | 0.027 | 0.002 | 0.158 | 0.154 | 0.174 | 0.038 | 0.038 | 0.043 |
| Congo, Dem. Rep. | 49 | 0.033 | 0.170 | 0.010 | 0.170 | 0.163 | 0.179 | 0.054 | 0.052 | 0.057 |
| Mexico | 41 | 0.087 | 0.013 | 0.006 | 0.111 | 0.160 | 0.165 | 0.036 | 0.036 | 0.036 |
| Turkey | 39 | 0.011 | 0.046 | 0.003 | 0.116 | 0.113 | 0.138 | 0.036 | 0.038 | 0.042 |
| Ghana | 39 | 0.056 | 0.108 | 0.024 | 0.231 | 0.248 | 0.253 | 0.047 | 0.042 | 0.048 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Sierra Leone | 34 | 0.049 | 0.123 | 0.025 | 0.207 | 0.254 | 0.249 | 0.058 | 0.050 | 0.056 |
| Guinea-Bissau | 30 | 0.014 | 0.275 | 0.018 | 0.156 | 0.142 | 0.174 | 0.063 | 0.063 | 0.062 |
| Ecuador | 25 | 0.099 | 0.043 | 0.017 | 0.072 | 0.114 | 0.113 | 0.042 | 0.040 | 0.041 |
| Colombia | 23 | 0.045 | 0.027 | 0.006 | 0.071 | 0.098 | 0.116 | 0.020 | 0.014 | 0.025 |
| Guyana | 22 | 0.230 | 0.094 | 0.035 | 0.117 | 0.155 | 0.151 | 0.058 | 0.058 | 0.062 |
| Costa Rica | 20 | 0.113 | 0.049 | 0.013 | 0.109 | 0.110 | 0.141 | 0.026 | 0.029 | 0.040 |
| Venezuela, RB | 18 | 0.117 | 0.040 | 0.010 | 0.112 | 0.144 | 0.147 | 0.044 | 0.040 | 0.043 |
| Paraguay | 18 | 0.024 | 0.034 | 0.008 | 0.109 | 0.119 | 0.125 | 0.037 | 0.034 | 0.040 |
| Nigeria | 18 | 0.150 | 0.228 | 0.025 | 0.160 | 0.195 | 0.213 | 0.082 | 0.070 | 0.079 |
| Jamaica | 17 | 0.194 | 0.031 | 0.011 | 0.113 | 0.135 | 0.145 | 0.050 | 0.046 | 0.044 |
| Portugal | 16 | 0.011 | 0.077 | 0.003 | 0.083 | 0.048 | 0.096 | 0.035 | 0.028 | 0.030 |
| Iran, Islamic Rep. | 16 | 0.031 | 0.123 | 0.054 | 0.479 | 0.467 | 0.497 | 0.073 | 0.066 | 0.069 |
| Oman | 16 | 0.036 | 0.177 | 0.160 | 0.125 | 0.145 | 0.162 | 0.120 | 0.118 | 0.112 |
| Greece | 16 | 0.008 | 0.061 | 0.006 | 0.075 | 0.051 | 0.097 | 0.029 | 0.024 | 0.026 |
| Dominican Republic | 15 | 0.168 | 0.031 | 0.011 | 0.096 | 0.114 | 0.134 | 0.057 | 0.053 | 0.056 |
| Indonesia | 15 | 0.040 | 0.028 | 0.078 | 0.122 | 0.148 | 0.151 | 0.031 | 0.030 | 0.033 |

[a] Only countries with population above 500,000 are considered. For Euro 12 members, comovements are computed in relation to the other 11 countries. High-inflation countries with no data on *VY* or *VP* are not reported in the table.

Table 13 HIGH-INFLATION COUNTRIES: BEST ANCHOR BASED ON THE THREE CRITERIA

| *Country* | *Mean annual inflation rate (%)* | *Trade* | VP | VY |
|---|---|---|---|---|
| Nicaragua | 1168.4 | **U.S.** | U.S. | Euro |
| Bolivia | 702.4 | U.S. | **U.S.** | U.S. |
| Peru | 530.7 | U.S. | Euro | Euro |
| Argentina | 430.8 | Euro | Euro | Euro |
| Brazil | 288.4 | U.S. | U.S. | **Euro** |
| Chile | 106.9 | Euro | U.S. | U.S. |
| Israel | 78.2 | Euro | U.S. | **Euro** |
| Uruguay | 62.2 | Euro | Euro | U.S./Euro |
| Congo, Dem. Rep. | 48.7 | **Euro** | Euro | Euro |
| Mexico | 41.0 | **U.S.** | **U.S.** | Euro/Japan |
| Turkey | 39.4 | Euro | Euro | U.S. |
| Ghana | 38.7 | **Euro** | U.S. | Euro |
| Sierra Leone | 34.2 | **Euro** | **U.S.** | **Euro** |
| Guinea-Bissau | 30.5 | **Euro** | Euro | Japan |
| Ecuador | 25.0 | **U.S.** | **U.S.** | Euro |
| Colombia | 22.7 | U.S. | **U.S.** | **Euro** |
| Guyana | 22.3 | **U.S.** | **U.S.** | Euro |
| Costa Rica | 20.0 | **U.S.** | U.S. | U.S. |
| Venezuela | 18.5 | **U.S.** | **U.S.** | Euro |
| Paraguay | 17.8 | Euro | U.S. | Euro |
| Nigeria | 17.5 | **Euro** | **U.S.** | **Euro** |
| Jamaica | 16.6 | U.S. | U.S. | Japan |
| Portugal | 16.2 | **Euro** | **Euro** | Euro |
| Iran | 16.1 | **Euro** | Euro | Euro |
| Oman | 16.0 | Euro | U.S. | **Japan** |
| Greece | 15.6 | **Euro** | Euro | Euro |
| Dominican Republic | 15.1 | **U.S.** | U.S. | Euro |
| Indonesia | 15.0 | Japan | **U.S.** | Euro |

The table excludes countries with 1997 population below 500,000 and countries for which *VP* or *VY* is not available. Bold values apply if (1) highest trade share less second-highest trade exceeds 0.04, (2) magnitude of difference between lowest *VP* and next-lowest *VP* exceeds 0.025, or (3) magnitude of difference between lowest *VY* and next-lowest *VY* exceeds 0.005.

Table 13 summarizes the information from Table 12 by listing for each of the three criteria (trade, price comovement, and output comovement) which of the three anchors is best. A boldface entry means that the chosen anchor is much superior to the other two; a lightface entry means that the difference from at least one other anchor is small. More specifically, a bold entry in the trade column means that the highest trade share with one of the three potential anchors is more than 4 percentage points higher

than that of the second of the three. In the case of price comovements, a bold entry means that the absolute value of the difference between the most associated of the three and the second one is larger that 0.025. For the output comovement, the same definition applies with a cutoff of 0.005. These cutoff choices are arbitrary, but the reader, using the data reported in Table 12, can calculate another cutoff. These criteria emphasize the choice among potential anchors, rather than the choice of whether to retain an independent currency.

Several interesting observations emerge from Table 13. First, Japan is not an attractive anchor for virtually any of the high-inflation countries. Out of 96 entries in the table, only 8 (which includes one tie) are for Japan. No case has more than one of the criteria in favor of Japan.

Second, high-inflation Latin American countries are by no means a clear dollarization bloc. In fact, Brazil might be better served by adopting the euro. (Although there is no clear superiority in terms of trade or price comovements, the euro performs better in terms of comovement of output.) The case of Argentina is interesting: having one of the highest inflation rates, this country seems to be one of the best examples of a place with a high demand for an external currency anchor. However, as shown in Table 12, Argentina has been largely closed to international trade, and its output and price comovements are not high with any of the three potential anchors. So, other than its lack of commitment ability, Argentina does not appear to be an obvious member of a currency union with the euro or the U.S. dollar. In contrast, Mexico and Ecuador look much closer to the U.S. dollar than to the euro. The same conclusion applies to the Dominican Republic. Nicaragua has low comovements with all three anchors, but its exports go mostly to Europe. Hence, the euro might be a better choice than the U.S. dollar. Chile and Uruguay have higher exports to Europe, but they have larger comovements with the United States.

Third, looking at countries at the geographical boundaries of Europe, in some cases their natural anchor is the euro: this conclusion applies to Greece (which has joined the euro zone) and Turkey. Israel might be a good candidate for the euro, although it could also be well served by the U.S. dollar. As for Africa, trade shares are much higher with Europe. Comovements are, however, just as high with the United States. Ghana, Guinea-Bissau, and Sierra Leone seem to be natural euro clients, but other African countries are less clear.

We have measured lack of ability to commit according to past inflation experience. One could also look at institutional measures of potential commitment, such as the degree of central-bank independence. However, although this measure has some explanatory power for inflation perfor-

mance among OECD countries, it does not seem to explain much for developing countries.[20]

High-inflation countries are not the only potential clients of an anchor. If a country trades extensively with a potential anchor, then adopting the anchor currency may be a good strategy even if the inflation rate under autonomy is low. In Table 14, we report all the countries that have a trade share with at least one of the potential anchors of at least 9% of GDP. In the first column we report the name of the anchor that has the highest trade share; when more than one anchor has a share of at least 9%, we report all in decreasing order. For example, if country X's trade share was 15% of its GDP with the United States and 9% with the Euro 12, the entry will read U.S./Euro. In the next column, we report the name of the anchor with the highest comovements of prices and output, with the same convention as before concerning the bold entries.

The first inference from Table 14 is that the countries forming the Euro 12 area do seem to belong together. The same observation applies to other European countries that are not currently members of the Euro 12, such as Sweden and Switzerland. Second, African countries trade more with Europe than with the United States or Japan, so, by and large, the best potential anchor for Africa is the euro. Note that the CFA franc zone is already tied to the euro. Third, Central American countries trade much more with the United States. Fourth, for several East Asian countries, such as Hong Kong and Singapore, the U.S. dollar appears to be superior to the yen as a potential anchor. These Asian countries trade more with the United States than with Japan and are more closely associated with the U.S. business cycle. Canada is extremely tied to the United States in every dimension.[21]

Overall, we find that geographically connected currency areas tend to emerge with the U.S. dollar and the euro as the anchor. However, Japan does not emerge as much of an anchor. Putting together the results from Table 14 with those of Tables 12 and 13, we draw the following conclusions: (1) There seems to be a fairly clear dollar area including Canada, Mexico, most of Central America, and parts of South America (excluding Argentina and Brazil). Farther afield geographically, the dollar zone seems also to encompass some Asian countries, such as Hong Kong and Singapore. (2) The euro area includes all of western Europe and most of Africa. Argentina might actually be better served by joining the euro area than the dollar area. However, the only reason for Argentina to be seeking

20. See Alesina and Summers (1993) for OECD country evidence, and Cukierman (1992) for evidence on developing countries.
21. See Buiter (1999) for a discussion of this point.

Table 14 HIGH-TRADE-SHARE COUNTRIES: BEST ANCHOR BASED ON THE THREE CRITERIA

| | *Best anchor* | | |
|---|---|---|---|
| *Country* | *Trade*[a] | VP[b] | VY[b] |
| Algeria | Euro | Euro | Euro |
| Austria | Euro | **Euro** | **Euro** |
| Belgium–Luxembourg | Euro | **Euro** | **Euro** |
| Benin | Euro | **Euro** | Euro |
| Cameroon | Euro | Euro | U.S. |
| Canada | U.S. | **U.S.** | U.S. |
| Central African Republic | Euro | **Euro** | Euro |
| Chad | Euro | Euro | Euro |
| Congo, Dem. Rep. | Euro | Euro | Euro |
| Congo, Rep | Euro | Euro | Euro |
| Costa Rica | U.S. | U.S. | U.S. |
| Côte d'Ivoire | Euro | **Euro** | Japan |
| Cyprus | Euro | Euro | **Euro** |
| Dominican Republic | U.S. | U.S. | Euro |
| Ecuador | U.S. | **U.S.** | Euro |
| Gabon | Euro | Euro | **Euro** |
| Gambia, The | Euro | U.S. | Euro |
| Ghana | Euro | U.S. | Euro |
| Guinea-Bissau | Euro | Euro | Japan |
| Guyana | U.S./Euro | **U.S.** | Euro |
| Haiti | U.S. | U.S. | **Euro** |
| Honduras | U.S. | **U.S.** | **U.S.** |
| Hong Kong, China | U.S. | U.S. | Euro |
| Iran, Islamic Rep. | Euro | Euro | Euro |
| Ireland | Euro | **Euro** | **Euro** |
| Jamaica | U.S. | U.S. | Japan |
| Jordan | Euro | U.S. | Euro |
| Kenya | Euro | Euro | U.S./Euro |
| Madagascar | Euro | Euro | Euro |
| Malaysia | Japan | U.S. | Euro |
| Mauritania | Euro | Euro | **Euro** |
| Mauritius | Euro | Euro | U.S. |
| Morocco | Euro | **Euro** | **Euro** |
| Netherlands | Euro | **Euro** | **Euro** |
| Nicaragua | U.S. | U.S. | Euro |
| Niger | Euro | **Euro** | Euro |
| Nigeria | Euro/U.S. | **U.S.** | **Euro** |
| Oman | Euro/Japan | US | **Japan** |
| Panama | Japan/U.S. | **U.S.** | Euro |
| Papua New Guinea | Japan | U.S. | Japan |
| Romania | Euro | U.S. | Euro |
| Saudi Arabia | Euro | **U.S.** | U.S./Euro |
| Senegal | Euro | **Euro** | Euro |

Table 14 CONTINUED

| Country | Best anchor | | |
|---|---|---|---|
| | *Trade*[a] | VP[b] | VY[b] |
| Sierra Leone | Euro | **U.S.** | **Euro** |
| Singapore | U.S./Japan | **U.S.** | Euro |
| Sweden | Euro | **Euro** | **Euro** |
| Switzerland | Euro | **Euro** | **Euro** |
| Syrian Arab Republic | Euro | **U.S.** | **Euro** |
| Togo | Euro | **Euro** | Euro |
| Trinidad and Tobago | U.S. | U.S. | Euro |
| Tunisia | Euro | Euro | Euro |
| United Arab Emirates | Japan/Euro | U.S. | Euro |
| Venezuela, RB | U.S. | **U.S.** | Euro |

[a] The table excludes countries with 1997 population below 500,000 and countries for which *VP* or *VY* is not available. The best anchor according to the trade criterion is shown only when the trade share exceeds 9%. When there is more than one anchor country for which the trade share exceeds 9%, we list the anchors in descending order of the trade shares.

[b] Bold values apply if the magnitude of the difference between the lowest *VP* and the next-lowest *VP* exceeds 0.025 or the magnitude of the difference between the lowest *VY* and the next-lowest *VY* exceeds 0.005.

any anchor is her history of high inflation. (3) There does not seem to be any clear yen area. (4) There are several countries that do not appear in Tables 12–14. These are countries with low inflation that do not trade much with any of the three potential anchors. Primary examples are India, Australia, and New Zealand.

It is worthwhile to compare our results briefly with those of Ghosh and Wolf (1994), who use a different approach to assess the pros and cons for regions and countries to form currency unions. They argue that optimal currency areas are typically formed by countries that are geographically disconnected. For example, they conclude that Europe and the states of the United States are not optimal currency areas. We have not examined the U.S. states, but Europe does present a good case for a currency union based on our examination of the patterns of trade and comovements of prices and outputs. More generally, despite some exceptions, geographical proximity typically fits well with our criteria for currency unions. The differences between our findings and those of Ghosh and Wolf seem to arise because they do not emphasize the link between currency unions and trade and because they assume a very high cost from imperfect synchronization of business cycles.

Ideally, we would go beyond the simple criteria thus far advanced to evaluate the relative costs and benefits of the trade-off leading to the choice of currency adoption. For example, should a country such as

Argentina with high inflation but low comovements with the United States and the euro zone remain autonomous or use the dollar or the euro? How much can trade benefits of a currency union compensate for the loss of monetary autonomy? To answer these questions, we need more quantitative information than we have yet generated.

## 6. *What Changes with Currency Adoption?*

Thus far, we have discussed the possible configuration of currency areas based on the behavior of inflation, trade, and the comovements of prices and outputs that prevail (in most cases) before the creation of a currency union. In choosing whether to join a monetary area, a potential entrant would have to estimate the values of trade and comovements that would apply after the entry. In practice, this calculation is difficult—for the potential entrant and also for the econometrician.[22] In the next section, we discuss estimates of effects from joining a currency union on international trade flows. Then we discuss some new estimates of effects of currency union on trade and on comovements of prices and outputs.

### 6.1 CURRENCY UNIONS AND INTERNATIONAL TRADE: THE AVAILABLE EVIDENCE

Most of the existing empirical work on the effects of currency unions on trade flows has been framed in the context of the standard *gravity model.* According to this approach, the bilateral trade between a pair of countries is increasing in their GDPs and is inversely related to their distance, broadly construed to include all factors that create "trade resistance." The gravity equation is then augmented with a dummy variable indicating whether or not the countries share the same currency. The estimate of the coefficient on this dummy is interpreted as the currency-union effect. In the seminal paper in this area, Rose (2000) reports that bilateral trade between two countries that use the same currency is, controlling for other effects, over 200% larger than bilateral trade between countries that use different currencies.

The apparently large effect of currency unions on trade is surprising, because estimates of the effect of reduced exchange-rate volatility on trade are small [see, for example, De Grauwe and Skudelny (2000), Frankel and Wei (1992), and Eichengreen and Irwin (1995)]. Moreover, fees on currency conversion are typically a small percentage of total transaction

22. Issing (2001) argues that one should expect that prices and outputs will move more closely together in the European Union after the adoption of the euro.

Table 15 EMPIRICAL STUDIES OF THE EFFECT OF CURRENCY UNION ON TRADE

| *Authors* | *Significance*[a] | *Point estimate of increased trade from currency union* |
|---|---|---|
| Rose (2000) | s | ≈ 240% |
| Frankel and Rose (1998) | s | ≈ 290% |
| Engel and Rose (2002) | s | ≈ 240% |
| Persson (2001) | ns | ≈ 40% |
| Tenreyro (2001) | ns | ≈ 60% |
| Pakko and Wall (2001) | ns | ≈ −55% |
| Glick and Rose (2002) | s | ≈ 100% |
| Rose and van Wincoop (2001) | s | ≈ 140% |
| Rose (2002) | ns, s | −68% to +708% |
| Lopez-Cordova and Meissner (2001) | s | ≈ 100% |
| Levy (2001) | s | ≈ 50% |
| Nitsch (2002) | s | ≈ 85% |
| Flandreau and Maurel (2001) | s | ≈ 220% |
| Klein (2002) | s | ≈ 50% |

[a] s = statistically significantly different from zero, ns = not significant.

costs.[23] On the other hand, as already discussed, border effects on trade are large, and perhaps these large effects can be explained by the necessity to use different currencies on the two sides of a border.

Numerous empirical studies, summarized in Table 15, have examined and extended Rose's research. Pakko and Wall (2001) focus on time-series variation, which involves cases in which currency union is either implemented or abandoned. Their findings reveal a negative, though insignificant, effect of currency union on trade. However, Glick and Rose (2002) use an expanded panel data set that includes more episodes of regime switching. With this set, they find large and positive estimates from the time-series variation.

Rose (2002) provides new estimates of the effect of currency unions on trade, making use of the time-series as well as cross-sectional variation in the data. This study reports a wide range of estimates, using different samples and techniques. Point estimates range from a negative, though insignificant, effect of −68%, using fixed effects in the original sample, to a 708% effect using a matching sample technique and a much broader database.

Rose and van Wincoop (2001), Nitsch (2002), Melitz (2001), Klein (2002),

23. The argument that currency conversion fees are low may not apply to trade in capital, where the currency turnover is extremely high and hence small proportionate costs can translate into large disbursements.

and Levy (2001) address problems of aggregation bias, arguing that pooling different currency unions may mask differential effects. Yet, all these studies point toward a significantly positive effect on trade. Thom and Walsh (2002) present a case study on Ireland's break with sterling, finding no significant effect on trade. Other studies, including Flandreau and Maurel (2001) and Lopez-Cordova and Meissner (2001), focus on pre-W.W. I data.

The underlying assumption in the various empirical studies is that currency unions are randomly chosen. Standard endogeneity problems can, however, confound the estimates. For example, the presence of currency union may encourage trade, but the presence or potential for substantial trade may also stimulate the formation of a currency union. The use of country-pair fixed effects, employed in some of the studies, may not alleviate this simultaneity problem, because a shift at some point in trade linkages may be related to the change in the propensity to form a currency union.

Similarly, the existence of a currency union may reflect unmeasured characteristics that also influence the volume of bilateral international trade. The currency-union dummy can get credit for the effects of these unobserved variables. As examples, compatibility in legal systems, greater cultural links, and tied bilateral transfers may increase the propensity to form a currency union as well as strengthen trade links between two countries. In these cases, the OLS estimate of the currency-union effect on trade tends to be biased upward. Other omitted variables may bias OLS estimates in the opposite direction. For example, a higher level of monopoly power means higher markups, which tend to deter trade. At the same time, a greater degree of monopoly distortion may lead to higher inflation rates under discretion and thereby increase the desire to join a currency union as a commitment device to reduce inflation.

Persson (2001) voices a different critique based on the potential for self-selection in the decision to form a currency union. Among other distinctive features, countries that have been engaged in currency unions during the past decades are typically small and poor, tend to be geographically close, and are likely to share tight cultural links. Examples are the 15 countries of the CFA-franc zone in Africa, the seven members of the Eastern Caribbean Currency Area, and the unilaterally dollarized Panama, Puerto Rico, and Bermuda. Systematic differences in observable characteristics can distort OLS estimates when the effect of using the same currency differs across groups or when there are other types of nonlinearities in the trade relation that have been ignored. Using semiparametric methods, Persson's study finds little support for a currency-union effect on trade; his point estimates, ranging from 13% to 45%, are not statistically signifi-

cantly different from zero. This result is not surprising, however, because the matching procedure—designed to deal with nonlinearities in observable variables—throws out much of the information in the sample. Moreover, as already noted, when Rose (2002) applies the matching approach to a broader data set, he obtains an enormous estimate for the effect of currency union on trade.

Another concern is a mechanical problem caused by sample selection. Previous estimates of the currency-union effect were based on a sample of countries with positive bilateral trade flows. Pairs of countries with zero trade flows—typically pairs of small countries—were excluded from the sample to satisfy the log specification of the gravity equation. This issue may be important, because roughly half of the annual country-pair observations exhibit zero trade.

### 6.2 THE EFFECTS OF CURRENCY UNIONS: NEW RESULTS

To address the various estimation issues, Tenreyro (2002) begins by studying the empirical determinants of past and present currency unions.[24] She uses a probit analysis for all country pairings from 1960 to 1997 with four potential currency anchors: Australia, France, the United Kingdom, and the United States.[25] The anchors used here are different from the hypothetical ones considered before for obvious reasons: the euro did not exist before 2002, and the now defunct French franc was historically an important anchor currency. Interestingly, the yen was never an anchor for anyone.

The main results, reported in Table 16, are that a currency union with one of the four candidate anchors is more likely if the client country (1) is closer geographically to the anchor, (2) has the same language as the anchor, (3) is a former or current colony of the anchor, (4) is poorer in terms of per capita GDP, and (5) is smaller in population size. The probability is increasing in the per capita GDP of the anchor (among the four considered). Elements that do not matter significantly include island or land-locked status and a common border with the potential anchor.

Our general idea is to use the estimated model for the propensity of a country to enter into a currency union to form an instrumental variable for the currency-union dummy. However, it does not work to use the estimates from the probit equation directly, because the determinants of the probability of currency union (such as distance and other gravity vari-

24. Persson (2001) also modeled the choice of currency union, but he did not use this analysis to construct instrumental variables.

25. Her analysis, unlike Rose's (2000), treats the CFA countries as in a currency union with France. She also departs from Rose in treating the ECCA countries as in a currency union with the United States since 1976 and with the United Kingdom before that.

Table 16 PROPENSITY TO ADOPT THE CURRENCY OF MAIN ANCHORS

| *Statistic* | *Coefficient* | *Std. error* | *Marginal effect at mean* |
|---|---|---|---|
| min(log per capita GDP in pair) | −0.1586* | 0.061 | −0.0015 |
| max(log per capita GDP in pair) | 1.7167* | 0.385 | 0.0163 |
| min(log population in pair) | −0.1352* | 0.048 | −0.0013 |
| max(log population in pair) | 0.2372 | 0.127 | 0.0023 |
| min(log area in pair) | −0.0546 | 0.046 | −0.0005 |
| max(log area in pair) | 0.2181* | 0.072 | 0.0021 |
| Regional-trade-agreement dummy | −0.8864* | 0.277 | −0.0032 |
| log distance (km) | −0.8766* | 0.143 | −0.0083 |
| Border contiguity dummy | −1.2398* | 0.619 | −0.0033 |
| Landlocked-client dummy | −0.1522 | 0.242 | −0.0013 |
| One-island-in-pair dummy | 0.0226 | 0.240 | 0.0002 |
| Two-islands-in-pair dummy | 1.1880* | 0.437 | 0.0512 |
| Common-language dummy | 0.7487* | 0.216 | 0.0124 |
| Ex-colony–colonizer dummy | 1.8799* | 0.285 | 0.1369 |
| Current-colony (or territory) dummy | 0.8491* | 0.239 | 0.0253 |
| Pseudo $R^2$ | 0.473 | | |
| Number of observations | 29,564 | | |

Dependent variable: currency-union dummy. The sample consists of country pairs that include the four candidate anchors: Australia, France, the United Kingdom and the United States. The equations are for annual data from 1960 to 1997, include year effects, and allow for clustering over time for country pairs. The definition of currency union treats the CFA franc countries as linked to France and treats the ECCA countries as linked to the United States since 1976 and to the United Kingdom before 1976. The mean of the currency-union dummy for this is 0.051. For the sample that regards the CFA countries as unlinked to France and the ECCA countries as unlinked to the United States or the United Kingdom, the mean is 0.024. The last column shows the marginal effect, evaluated at the sample mean, of each explanatory variable on the estimated probability of a currency union. For dummy variables, the effect refers to a shift from zero to one.

* Statistically significant at 1% level.

ables) also enter directly into the determinants of bilateral trading volume. Hence, Tenreyro (2002) adopts an indirect approach.

Consider any potential client country, $i$, which is evaluating the adoption of a currency with one of the four anchors considered, denoted by $k = 1, 2, 3, 4$. The probit regression determines the estimated probability, $p(i, k)$, of the currency adoption. This probability depends on the distance between $i$ and $k$ and the other variables mentioned above. If the countries take their currency-union decisions independently, then the joint probability that $i$ and $j$ use the currency of anchor $k$ will be given by

$$J^k(i, j) = p(i, k)p(j, k).$$

Note that $J^k(i, j)$ will be high if countries $i$ and $j$ are both close to potential anchor $k$. The idea, for example, is that Ecuador and El Salvador currently

share a common money (the U.S. dollar) not because they are close to each other, but rather because each is close to the United States, and hence each was independently motivated to adopt the U.S. dollar.

The joint probability that $i$ and $j$ use the same foreign currency (among the four candidates considered) will then be given by the sum of the joint probabilities over the support of potential anchors $k$:[26]

$$J(i, j) = \sum_{k=1}^{4} J^k(i, j) = \sum_{k=1}^{4} p(i, k)p(j, k)$$

One can then use the variable $J(i, j)$ as an instrument for the currency-union dummy, for example, in equations for bilateral trade between countries $i$ and $j$. The underlying assumption for the validity of this instrument is that the bilateral trade between countries $i$ and $j$ depends on bilateral gravity variables for $i$ and $j$ but not on gravity variables involving third countries, notably those associated with the potential anchor countries $k$. These gravity variables involving third countries affect the propensity of countries $i$ and $j$ to be part of the same currency zone and thereby influence bilateral trade between $i$ and $j$ through that channel. However, these variables do not (by assumption) directly influence the bilateral trade between $i$ and $j$.

Tenreyro (2002) uses the new instrument for the currency-union dummy to estimate relations for pairs of countries for trading volume, comovement of prices, and comovement of outputs. We present some of these results in Table 17, which, for brevity, reports only the estimated coefficients of the currency-union variable.

For bilateral trade, the results use annual data from 1960 to 1997 for all pairs of countries. Taking account of data availability, this system comprises over 300,000 observations (when we include the roughly half of the sample that has zeros for bilateral trade). The dependent variable is measured as log(trade + positive constant), where the presence of the positive constant allows us to include the zero-trade observations in the regressions. For the results shown in Table 17, the constant is set to 100 1995 U.S. dollars. The system includes as independent variables a set of usual gravity measures—log of geographical distance, membership in a regional trade agreement, common language, former and current colonial relationship, common colonizer, common border, and island and landlocked status—along with the logs of GDP per capita, population, and

26. For a pair of anchors, say, $k_1$ and $k_2$, the probability is $J(k_1, k_2) = p(k_1, k_2)[1 - p(k_1, k_3) - p(k_1, k_4)] + p(k_1, k_2)[1 - p(k_2, k_3) - p(k_2, k_4)] + \sum_{s=3}^{4} p(k_1, k_3)p(k_2, k_3)$.

Table 17 ESTIMATED COEFFICIENTS OF CURRENCY-UNION DUMMY IN VARIOUS SYSTEMS

| | *Coefficient (standard error)* | | | |
|---|---|---|---|---|
| *System* | *OLS* | *OLS with country effects* | *IV* | *IV with country effects* |
| log(bilateral trade + 100), $N = 348{,}295$ | 0.75 (0.20) | 0.91 (0.18) | 1.56 (0.44) | 2.70 (0.44) |
| Comovement of prices, mean = −0.16, $N = 9027$ | 0.0690 (0.0058) | 0.0456 (0.0028) | 0.2433 (0.0243) | 0.0874 (0.0080) |
| Comovement of outputs, means = −0.07, $N = 7610$ | 0.0029 (0.0026) | 0.0000 (0.0011) | 0.0119 (0.0061) | −0.0020 (0.0022) |

The equations for bilateral trade use annual data from 1960 to 1997, include year effects, and allow for clustering of the error terms over time for country pairs. The dependent variable is log(trade + 100), where trade is measured in 1995 U.S. dollars. The value 100 is close to the maximum-likelood estimate of the constant in the expression log(trade + constant). The explanatory variables included, aside from the currency-union dummy, are log(distance); dummy variables for contiguity, common language, colonial relationships, landlocked, and island; and the values for each country in the pair of log(per capita GDP), log(population), and log(area). The definition of currency union treats the CFA franc countries as linked to France and treats the ECCA countries as linked to the United States since 1976 and to the United Kingdom before 1976. Country effects refer to each member of the pair (not to a country pair). The instrumental variable (IV) systems include as an instrument for the currency-union dummy the variable described in the text. The equations for comovement include only one observation for each pair, corresponding to the period 1960–1997. The explanatory variables then refer to averages over time. Standard errors are in parentheses.

area for each country in a pair.[27] The OLS estimates of the gravity variables are typically significant.[28]

Table 17 shows that the estimated coefficient on the currency-union dummy variable is 0.75 (s.e. = 0.20) when country fixed effects are excluded, and 0.91 (0.18) when country fixed effects (not country-pair effects) are included. These results accord reasonably well with those presented by Rose (2000), despite two major differences in the approaches. First, since he used log(trade) as the dependent variable, he discarded all of the zero-trade observations (which, as mentioned, constitute roughly half of the sample). Second, we defined the currency-union dummy more liberally than Rose, in that we treated the CFA franc countries as in a union with the French franc and the ECCA countries as in a union with the U.S. dollar or the British pound (depending on the period).

27. See the footnote to Table 17 for the list of independent variables.
28. The error terms in the systems are allowed to be correlated over time for a given country pair.

The estimated effect of the currency-union dummy variable is larger if we adopt Rose's more restrictive definition of a currency union.[29]

More interestingly, the estimated effects of currency union on bilateral trade become larger when we estimate by instrumental variables, using the instrument discussed before. As shown in Table 17, the estimated coefficient on the currency-union dummy variable becomes 1.56 (0.44) when country fixed effects are excluded, and 2.70 (0.44) when they are included.[30] Hence, these results support the argument that currency union has an important positive effect on bilateral trade. Moreover, these instrumental estimates provide some reason to believe that the causality runs from currency union to trade, rather than the reverse.

The comovement of prices is measured by the negative of the standard error $VP_{ij}$ discussed before. In this case, the sample consists of one observation (estimated for 1960–1997) on each country pair for pairs that have the necessary data. We relate this measure of price comovement to the gravity variables already mentioned and to various measures of country size (logs of per capita GDP, population, and area). Most of the gravity variables turn out to be statistically insignificant in the estimates, although common language and a common colonial heritage are associated with greater price comovement. Comovement also rises with the log of per capita GDP of each country but falls with the log of area of each country.

Table 17 shows that the currency-union dummy is significantly positive for price comovement, with an estimated coefficient of 0.069 (s.e. = 0.006) when country fixed effects are excluded, and 0.046 (0.003) when they are included. These estimated effects are substantial relative to the mean of the comovement variable (the negative of the price-equation standard deviation), which is −0.16. The positive estimated effect of currency union on price comovement may emerge because currency-union countries avoid the sometimes volatile inflation rates and nominal exchange rates that characterize other regimes. The instrumental estimates are even higher than those generated by OLS. In this case, the estimated coefficients are 0.24 (0.02) when country fixed effects are excluded, and 0.087 (0.008) when they are included.

The comovement of outputs is measured by the negative of the standard error $VY_{ij}$ discussed before. The sample again comprises one observation (estimated for 1960–1997) on each country pair with the available

29. The OLS estimates become 1.24 (0.25) without country fixed effects, and 1.06 (0.23) with country fixed effects.

30. The estimated effects are even larger if we adopt Rose's (2000) more restrictive definition of currency unions. In the instrumental estimation, the estimated coefficients of the currency-union dummy variable are then 2.72 (0.75) when country fixed effects are excluded, and 4.68 (0.79) when they are included.

data. The explanatory variables are the same as those used for price comovements. The main effects from the gravity variables turn out to be positive relationships with a common border, a common language, and prior and current colonial linkages. However, Table 17 shows that the estimated coefficients on the currency-union dummy variable are typically insignificantly different from zero. These results may arise because, as discussed before, the theoretical link between currency union and output comovement is ambiguous.

## 7. *Conclusions*

The basic message of this paper is twofold. First, based on the historical data on inflation, trade, and comovements of prices and outputs, we argued that there exist well-defined dollar and euro areas but no clear yen area. Second, it is likely that the adoption of another country's currency increases bilateral trade and raises the comovement of prices. These responses suggest that our examination of the trade patterns and comovements that applied before the adoption of a common currency would underestimate the potential benefits from joining a currency union.

Several issues should be considered in future empirical research. First, the results of the instrumental estimation for the effects of currency union need to be analyzed more fully. Second, these results can be used to estimate how the introduction of a currency union would affect trade and the comovements of prices and outputs for individual country pairs under the hypothetical adoption of a currency union with a specified anchor country. These results would then feed back into our previous analysis of the desirable pattern of world currency unions. Third, using methods analogous to those used in this paper, we can assess the formation of currency unions that are not linked to a major anchor. For example, we can evaluate a Latin American currency union or the proposed unions in southern Africa and among the Persian Gulf states. Fourth, we expect to make particular use of the evidence that accumulates from the experience of the European Monetary Union.

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# *Comment*

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This is a very very aggressive paper, and accordingly, a great pleasure to discuss. Andy called me and asked: "How about I discuss the empirical issues and you focus on the rest?" Little did I know that the little bugger had read the paper and I hadn't. But let me stand by our agreement.

This paper says Iraq is part of a U.S. currency union, and it pays a lot of attention to the Comoro Islands, wherever they are. I think this is like